Technology Corridor

Are Distributed Energy Resources Gaining Traction?

A 10-year horizon.

By Dan Rastler

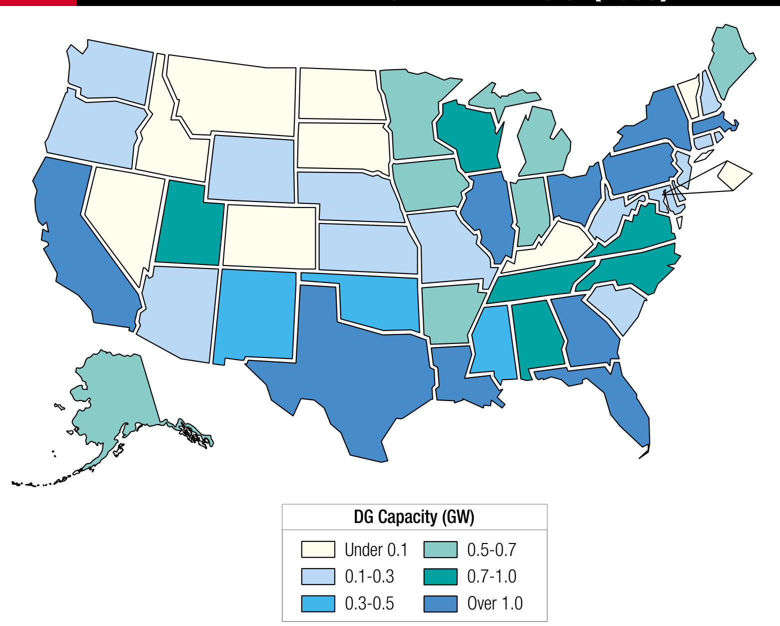
What does the current landscape look like for distributed energy resources (DER)? What applications and business models are being pursued by leading companies, and where can we expect to find DER in the next 10 years—in 2015?

An EPRI white paper, *Distributed Energy Resources: Current Landscape and a Roadmap for the Future*, developed with input from industry stakeholders, provides a broad-based picture of the current state and potential future of DER. The project team conducted interviews with more than 15 utilities and systems developers. These interviews offer a diverse portrait of different approaches to DER and an up-to-date, "on-the-ground" look at energy company attitudes toward DER.

Overall, EPRI found a renewed interest in DER. Increasingly, evidence suggests DER could have significant impact on the future of the grid and its design, including better utility asset utilization and less expensive system upgrades to meet new peak demands. Opportunities also are being explored for DER to be applied in joint utility/end-user applications—to meet both customer end-use needs as well as utility grid support—and thereby to capture dual benefits.

However, much remains to be done to reduce the costs of technology, facilitate applications in concert with the needs of the grid, and remove policy barriers.

Figure 1 Interconnected DER Capacity in the U.S. (2003)



From the 1990s to Today

In the mid to late 1990s, the energy industry in the United States witnessed a growing wave of interest in the alternative energy sector, particularly in DER. This interest was fueled by several drivers, including electric utility deregulation, availability of cheap and plentiful natural gas, new non-utility market entrants such as Enron, and the prospect of exciting new breakthroughs in small generation options that could change the landscape of how electricity was generated and delivered. By 2003, the picture had changed. Many of the preconditions and drivers anticipated for DER growth had experienced delays and reversals, and the prospects for large markets looked less hopeful.

Today, the electric utility industry faces continued challenges and uncertainties. Over the next decade, the cost structure of the generation sector is anticipated to increase considerably due to rising fuel costs, environmental regulations, and energy security concerns. A lack of consensus exists on future utility business models—whether they will be supply-side commodity-based or will be transformed into a more demand-side services business. In addition, substantial new investments in electric transmission and distribution system infrastructure are needed to address load growth and increase reliability.

These key industry uncertainties continue to drive interest in the role of distributed power, particularly in their opportunity to meet peak demand and use precious natural gas resources more efficiently. Also, there still is hope for new technologies—especially certain energy storage systems and high-efficiency hybrid options that have the potential to significantly affect the course of supply-side and demand-side utility business models.

Within this context, the outlook for DER today once again has changed. Recent mega-city blackouts, dramatic reductions in investments in central-station plants, and an aging T&D infrastructure point to the need to continue to follow DER developments and to guide future developments and applications so that they will benefit the electric system and all stakeholders.

In the regulatory arena, federal and state energy programs and certain state regulatory incentive programs are creating new opportunities for DER deployment. Applications have expanded and are now being pursued in three realms: end-use, grid support, and energy supply.

Current Landscape

At the end of 2003, the United States had an estimated 234 GW of installed DER (defined as generation less than 60 MW). However, 81 percent of this capacity comprises small-to-medium reciprocating engines serving end-user needs for emergency/standby applications. Only 30 GW is interconnected with the electrical T&D system. DER capacity that functions as part of the grid (grid-connected) accounts for only 3 percent of the U.S. electric grid capability of 953 GW.[1]

FIGURE 2 PERCENT OF DER CAPACITY BY TECHNOLOGY AND APPLICATION

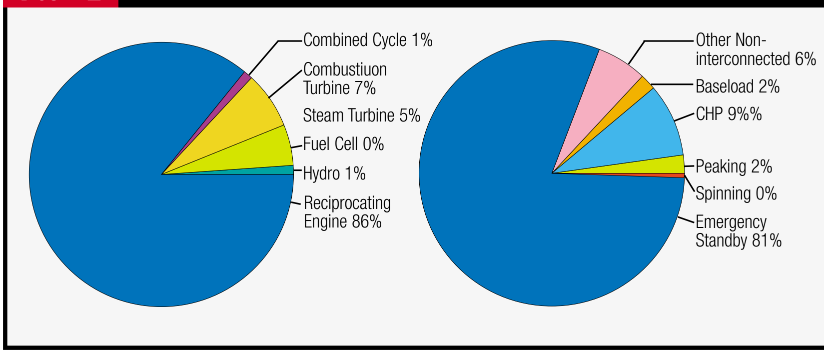


FIGURE 3 RANGE OF TOTAL ENERGY COST ($/KWH)

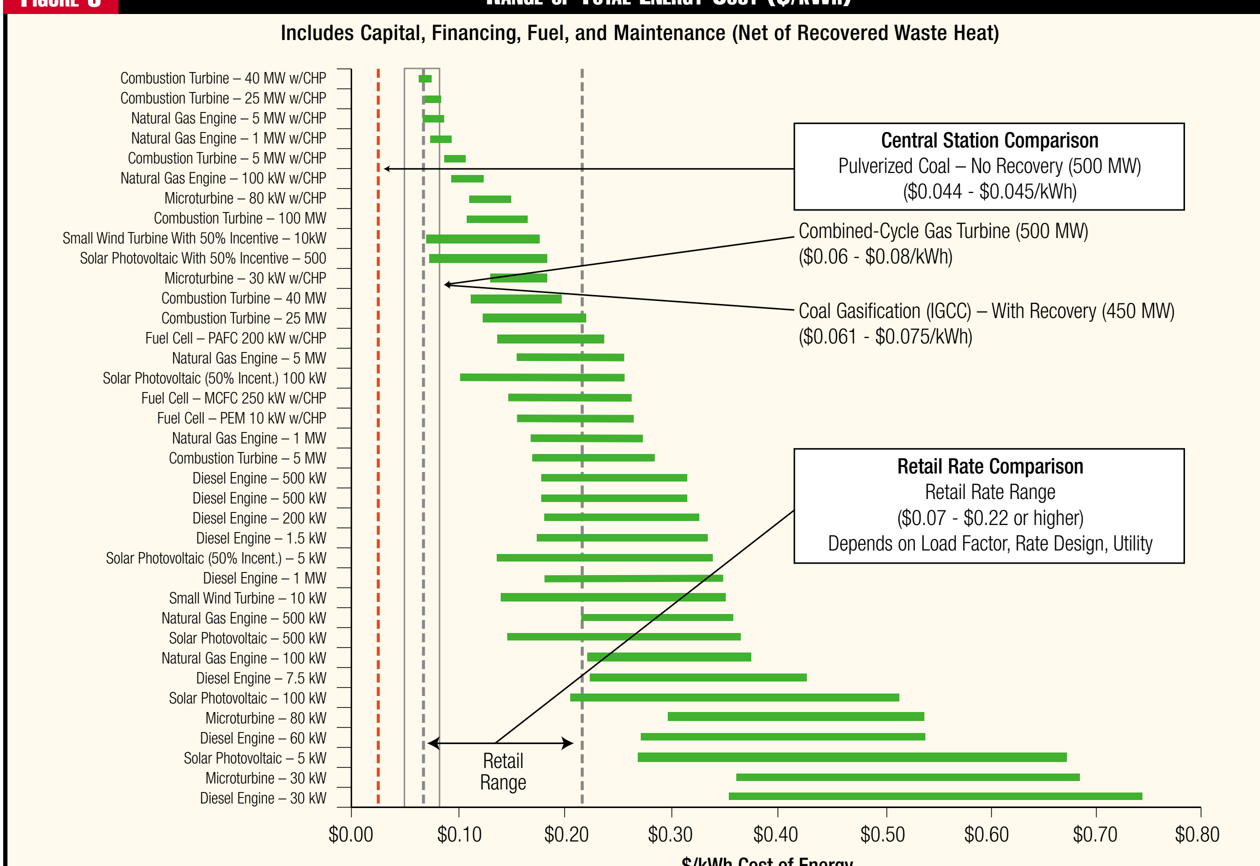


Figure 1 illustrates the total interconnected DER capacity in the United States, and Figure 2 illustrates how total DER capacity is distributed by technology type and application. Among the technologies, reciprocating engines dominate the current landscape, followed by combustion turbines. On the applications side, emergency/standby applications are in the majority, followed by combined heat and power (CHP). The United States has about 4.4 GW of installed wind generation and less than 0.5 GW of photovoltaic systems, and increasing trends for continued deployment over the next 10 years are due primarily to state-mandated renewable portfolio standards.

DER technologies are evolving toward decreasing costs, increasing efficiency, lower emissions, higher reliability, and more integrated and packaged systems, which are easier for plug-and-play interconnection.

Well-established technologies, such as reciprocating engines and combustion turbines, are making incremental improvements in cost, efficiency, and reliability, and are now able to achieve single-digit NO_x emissions cost-effectively.

Energy storage technologies, which offer promising new options that span many future applications, are an important finding of the white paper. In some cases they may avoid the fuel cost and emission constraints of generation technologies. In addition, due to synergies with the transportation sector, development and improvement of energy storage technologies may be accelerated.

Costs and Benefits

The costs to design, purchase, and install DER remain critical—and often prohibitive—factors in the overall economics of distributed power options. Financing alternatives, high operational efficiency, and low- or zero-fuel costs can mitigate the upfront capital costs, but the fact remains that total capital equipment costs for DER are expensive and need to be significantly reduced for larger market impacts to occur.

Figure 3 summarizes the total cost of energy for several DER technologies, sorted from lowest-cost to highest. While in practice these costs are very site- and location-specific, the assumed costs are within a representative range of industry reported technology costs. The sensitivity range is driven by a combination of capital cost, financing cost, fuel costs, maintenance costs, and waste heat recovery.[2] These results also take into account capacity factors, which are based on a range of expected operations for each technology. This comparison confirms that, while the costs of DER do not compare with the all-in cost of a 500-MW combined-cycle gas turbine, some DER can be cost-effective in comparison to the delivered cost-of-energy to end-users (retail rates) depending on rate structure and level, as well as customer load factor. Also, given the fact that future central-station electric production costs are likely to increase, especially under scenarios of mitigation of CO_2 release from new clean-coal technologies, the gap may be closing.

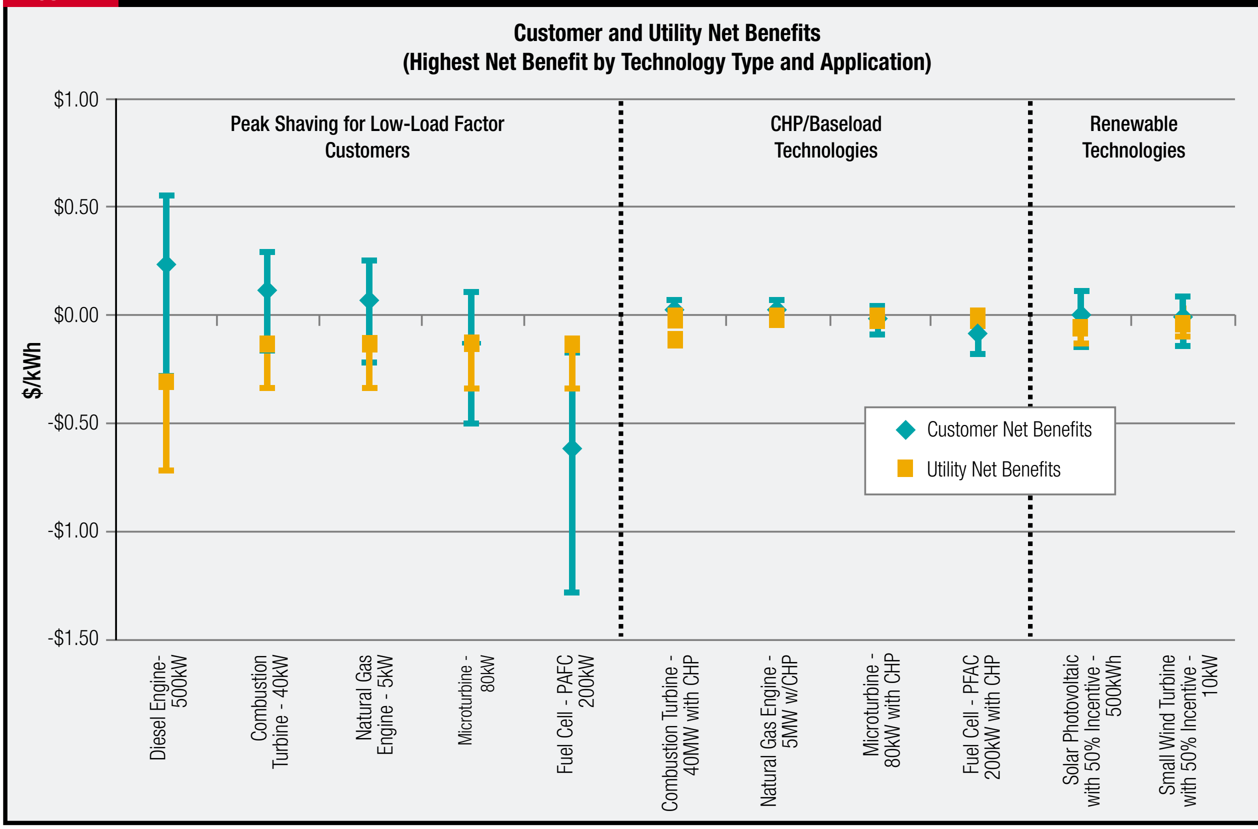
Because DER systems can provide power closer to the point-of-use, they have the potential to save customers money, provide back-up reliability, and help utilities minimize investments in

Bridging the Gap on DER

EPRI recommends the following actions be considered to close the technological and policy gaps to achieve the future DER pathways.

- **R&D**. Continued R&D is needed to lower the total capital installed cost, improve reliability, and enable fuel flexibility. Advances are needed to improve the cost and performance of energy storage technologies. Advances also are needed to develop improved integrated packages specifically to meet end-user market applications. For example, standardized energy solution packages are needed for CHP, back-up power, peak shaving, and UPS markets; research is needed to develop low-cost meters and a low-cost plug-and-play interconnection device for larger kVA DER options, especially for CHP and peak-shaving applications.
- **Grid Support**. Economic tools and best practices are needed to help evaluate and justify the technical and economic feasibility of incorporating DER into the T&D planning process. But because today's grid never really was designed for DER (or active, demand-side management options as well), new grid designs that maximize the value of DER (and especially energy storage) need to be developed. This will require more robust and sophisticated communication and protocols to enable control and dispatch of DER devices.
- **Energy Supply**. Development is needed of advanced, hybrid DER systems that are low-cost, efficient, and capable of being quickly deployed; standardization of products and pre-certification of systems are needed to verify the reliability of DER technologies; and vendors need to develop DER options that have the flexibility to burn alternative fuels.
- **Policy**. Utility rate structures, including standby charges, should be evaluated to determine if redesigned rates might provide win-win opportunities; incentives should be explored to encourage efficient DER-CHP systems; and encouragement should be given to market-based regional planning that recognizes the diversity of DER options and the need for a more flexible and dynamic grid. Such regional market-based integrated resource planning should be explored to enable the optimization of new supply-side resources, renewables, DER, T&D investments, energy efficiency, and the environmental trade-offs. —***D.R.***

FIGURE 4 **NET BENEFITS OF DER TECHNOLOGIES**



new T&D facilities to meet peak loads. In practice, however, it is increasingly difficult to monetize the benefits of DER because many benefits are both time- and location-specific. Also, competitive markets have not been able to monetize DER benefits, and many utility business units have been disaggregated into separate energy supply, transmission, and distribution entities, compounding difficulties to capture and monetize value from decentralized systems.

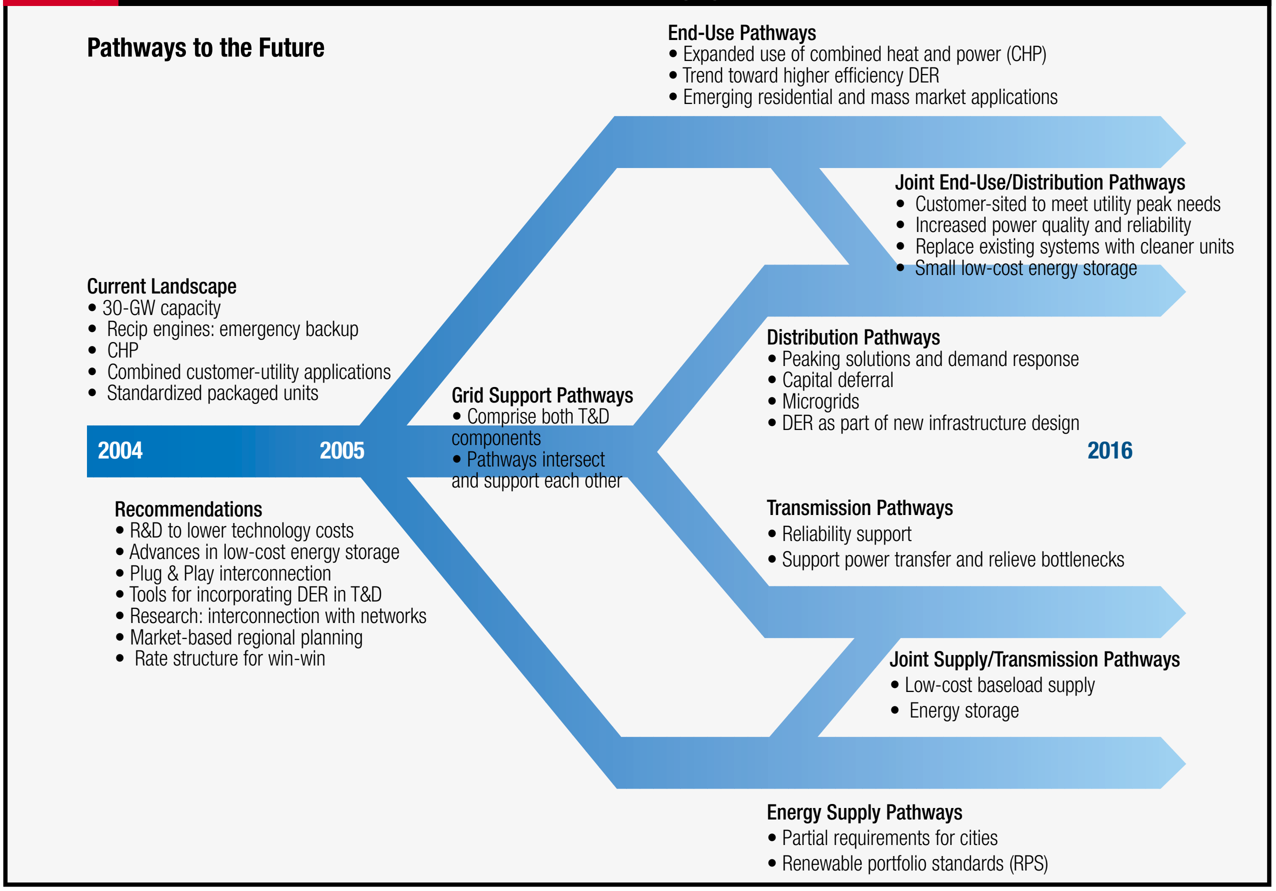
Figure 4 shows the net benefit results for both customer-side and utility-side DER applications categorized by type: peaking, combined-heat-and-power baseload, and renewable. The figure illustrates the range of possible values given variances in key variables. Technologies that display overlapping error bars or net benefits greater than zero could offer cost-effective DER solutions for customers or utilities. While the figure and analysis do not identify all cases where DER could be cost-effective, they do provide insights as to the type of applications that are most likely viable from each ownership perspective.

For example, the figure shows that combustion turbines and natural gas engines used in CHP applications offer potentially mutual benefits to both customers and utilities. We estimate up to 20 GW of CHP market opportunity, or 28 GW of CHP and other DER, even at today's high natural gas prices.[3] In contrast, a diesel engine, used in peak-shaving applications, may offer modest benefits to a customer but very little to a utility unless there is a demand or local T&D system benefit.

The figure also suggests emerging technologies such as microturbines and fuel cells have not yet demonstrated their benefits to either customers or utilities. In fact, the figure shows that peak-shaving DER applications as a whole may or may not be beneficial to customers, but uniformly provide little benefit from the utility perspective (again without grid benefits), though they may offer other advantages that help offset financial disincentives.

While customer-side applications of DER will continue to be important in the type and amount of future DER applications installed, "utility-side" applications are increasingly being considered. In certain cases, when electric distribution capacity shortfalls are examined, DER may be economical. However, our benchmarking analysis, along with current estimates of DER costs and benefits, shows fewer instances of cost-effective, utility-side DER applications. Therefore, it becomes almost necessary to capture both the private owner and utility owner benefits for DER to be an economical choice, and it is the intersection between the two

FIGURE 5 **PATHWAYS TO THE 2015 VISION OF DER**



perspectives that holds the most promise for a "win-win."

Business Models

Most DER systems today are being installed by a fragmented industry comprised of small engineering firms and consulting companies responding to end-user needs. This is, by far, the most prevalent business model, especially for solutions involving standby/back-up generation and, to a certain extent, CHP systems.

Electric utility companies, energy companies, and systems developers are approaching DER market opportunities with a variety of different business models. Generally, most regulated utilities are taking a "wait-and-see" approach to DER while monitoring technology developments, with several conducting pilot demonstration projects to become more familiar with the risk and business case. A few companies are offering standby/emergency back-up solutions to their customers.

A few companies are still working to develop a business and growth vector involving DER. For example, DTE's Energy|Now product line encompasses a range of technologies developed in cooperation with strategic partners, and Pepco Energy Services is involved with installing packaged microturbines in New York City and surrounding areas.

A few new companies have emerged that provide packaged systems for commercial/industrial and government facilities. Examples include RealEnergy, Northern Power Systems, Siemens Building Technologies, and UTC Power/Carrier. Most of these companies offer customer-owned systems, but several own and operate the systems and pass the energy savings on to end-users.

Pathways to the Future

EPRI's paper explores a number of pathways in which DER might evolve in the coming years (*see Figure 5*).

By far, end-users represent the primary pathway and application vector for DER systems, and they are likely to continue to be the chief area of application through 2015. End-users are seeking energy cost savings and higher reliability. They also desire turnkey energy solutions where a third party takes on the risks of the DER option and the energy offering. Possible end-use pathways for DER include replacement of existing backup power systems with cleaner dispatchable options, expanded use of CHP and other heat recovery/cooling applications, and new use of UPS's as both a back-up and a demand response tool.

The grid-support pathway comprises both T&D applications, in which utilities seek to avoid or defer infrastructure investment or to improve asset utilization. While DER has been said to offer the potential to avoid T&D infrastructure investments and provide other grid-support benefits, in practice these applications are very limited and site specific, primarily due to cost-effectiveness considerations and existing regulatory models. Utilities that have delayed infrastructure investments and have experienced load growth due to the rebounding economy are applying mobile DER (diesel gen sets) in critical areas, especially during the hot summer months. The awareness of using DER as a grid support option has increased among distribution planners, and some utilities have adopted the practice of evaluating DER options as part of their distribution planning process.

Absent better clarity on regulatory policy, DER options are likely to be introduced only incrementally for grid support and in new infrastructure redesign and implementation. Because some DER technologies have very low emissions, they may be employed in the near term in targeted applications to support the grid today. However, with the growing awareness of the aging infrastructure, incremental applications of DER might evolve in combination with the IntelliGrid (*see January 2005 issue, pp. 27-31*) , advanced distribution automation and monitoring technologies, and new active demand-side management technologies to achieve a more robust and reliable grid. This pathway will evolve first in power distribution systems where line voltages are less than 35 kV and will include a variety of DER options including energy storage.

In the area of energy supply, central-station plants will continue to be the least-cost energy supply options for most utilities. Over the next 10 years, however, generating companies will undertake a key transition of the current fleet to a new, more advanced fleet of supply-side generation options, and the cost structure to generate power is expected to increase considerably due to rising fuel costs, and environmental and security costs. Utilities face issues of how best to make the transition, how best to retire plants, and how to determine if there is a role for larger DER systems. The "distributed utility model" may help some utilities meet future peak power needs through a combination of DER, energy efficiency, and active demand control options. The pathways of DER into the future are likely to also build on past trends in the development of renewable wind and biomass systems and certain "in-city" natural gas generation assets.

In addition, in many cases, opportunities exist for joint applications—to meet both end-use and grid support needs, or for both energy supply and grid support. DER can be placed at strategic locations within the utility distribution system that can serve both end-use needs as well as offer support to the grid when it approaches its system limits. If incentives are offered to the end-user to install and operate the DER for grid support, then grid support applications have the potential to increase the market for end-use applications by helping defray capital or operating cost. Currently, incentives for DER in distribution system grid support applications are being explored in New York in California.

In sum, absent near-term breakthroughs in DER technologies, the appropriate integration of DER (especially energy storage systems) in the layout, design, and implementation of the new "future distribution grid" holds the most promise for DER in the long term for increased reliability and energy efficiency.

A copy of the EPRI white paper, "Distributed Energy Resources: Current Landscape and a Roadmap for the Future," can be downloaded at www.epri.com and at www.disgen.com.

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Endnotes:

1. Energy Information Administration, Form 860, 2003.
2. The assumptions and models underlying these cost calculations are detailed in *Economic Costs and Benefits of Distributed Energy Resources: EPRI Technical Update*: Aug. 16, 2004, Energy and Environmental Economics, San Francisco, Calif.: 2004.
3. The Potential U.S. Market for Distributed Generation, Resource Dynamics Corp., Vienna, Va., June 2004.